

The background is a dark blue grid with white technical drawings of various gears and mechanical components. Some gears are solid white, while others are outlined with hatching. Thin white lines form a frame around the text and connect different parts of the gear assembly.

BASICS OF MECHANICAL ENGINEERING

**VINKEL KUMAR ARORA
GURJEET SINGH
KRISHAN VERMA
LALIT BATRA**

BASICS OF MECHANICAL ENGINEERING

**Vinkel Kumar Arora
Gurjeet Singh
Krishan Verma
Lalit Batra**



NIPA GENX ELECTRONIC RESOURCES & SOLUTIONS P. LTD.

New Delhi-110 034



**NIPA GENX ELECTRONIC
RESOURCES & SOLUTIONS P. LTD.**

101,103, Vikas Surya Plaza, CU Block
L.S.C.Market, Pitam Pura, New Delhi-110 034
Ph : +91 11 27341616, 27341717, 27341718
E-mail: newindiapublishingagency@gmail.com
www: www.nipabooks.com

For customer assistance, please contact

Phone: + 91-11-27 34 17 17
Fax: + 91-11- 27 34 16 16
E-Mail: feedbacks@nipabooks.com

© 2023, Publisher

ISBN: 978-81-94766-85-8

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, including electronic, mechanical, photocopying recording or otherwise without the prior written permission of the publisher or the copyright holder.

This book contains information obtained from authentic and highly reliable sources. Reasonable efforts have been made to publish reliable data and information, but the author/s, editor/s and publisher cannot assume responsibility for the validity, accuracy or completeness of all materials or information published herein or the consequences of their use. The work is published with the understanding that the publisher and author/s are not attempting to render any professional services. The author/s, editor/s and publisher have attempted to trace and acknowledge the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission and/or acknowledgements to publish in this form have not been taken. If any copyrighted material has not been acknowledged, please write to us and let us know so that we may rectify the error, in subsequent reprints.

Trademark Notice: NIPA, the NIPA logos and their presentations (the way they are written/presented) in this book are the trademarks of the publisher and hence may not be used without written permission, if copied or used without authorization, the infringer will be prosecuted as per law.

NIPA also publishes books in a variety of electronic formats. Some content that appears in print may not be available in electronic books, and vice versa

Composed and Designed by NIPA.

Contents

<i>Acknowledgement</i>	vii
------------------------------	-----

<i>Preface</i>	ix
----------------------	----

1. Thermodynamics..... 1

Vinkel Kumar Arora

1.1 Introduction.....	1
1.2 Macroscopic and Microscopic approaches of Thermodynamics	2
1.3 Thermodynamic System	3
1.4 Other Systems	6
1.5 Thermodynamic Property	6
1.6 Temperature, Equity of Temperature	14
1.7 Measurement of Temperature	17
1.8 Pressure	19
1.9 Thermodynamic Work and Heat	21
1.10 Other Types of Work.....	33
1.11 First Law of Thermodynamics (FLOT)	37
1.12 Second Law of Thermodynamics and Entropy (SLOT).....	50
1.13 Entropy.....	56
1.14 Third Law of Thermodynamics (TLOT).....	59
1.15 Multiple Choice Questions Practice Problems	60

2. Steam Generation..... 63

Vinkel Kumar Arora

2.1 Introduction.....	63
2.2 Steam Formation at a Constant Pressure.....	63
2.3 Thermodynamic Properties of Steam.....	65
2.4 Use of Steam Tables.....	70
2.5 Measurement of Dryness Fraction by Throttling Calorimeter	72

3. Steam Generator 75

Vinkel Kumar Arora

3.1 Introduction: Boiler	75
3.2 Classification of Boilers.....	75
3.3 Comparison of fire Tube Boiler and Water Tube Boiler	78
3.4 Functions of Mounting and Accessories	78
3.5 Constructional and Operational Details of Cochran Boiler.....	81

3.6	Constructional and Operational Details of Babcock and Wilcox Boiler	82
3.7	Boiler Mountings	84
3.8	Control Fittings	86
3.9	Boiler Accessories	88
4.	Refrigeration and Air Condition.....	93
	<i>Vinkel Kumar Arora</i>	
4.1	Introduction.....	93
4.2	Brief History of Refrigeration and Air-Conditioning	94
4.3	Necessity of Refrigeration & Air Conditioning	94
4.4	Applications	95
4.5	Methods of Producing Refrigeration Effect	96
4.6	Rating of Refrigerating Machine.....	97
4.7	Carnot refrigeration Cycle or Reversed Carnot cycle	97
4.8	Expression for Coefficient of Performance	98
4.9	Limitations of Reversed Carnot Cycle	101
4.10	Simple Vapour Compression Refrigeration System	102
4.11	Description of a Simple VCRS	103
4.12	Coefficient of Performance of Vapour Compression Refrigeration System (VCRS)	104
4.13	Theoretical Vapour compression cycle with different case	105
5.	Refrigerants.....	121
	<i>Vinkel Kumar Arora</i>	
5.1	Introduction.....	121
5.2	Refrigerant Selection Criteria	121
5.3	Types of Refrigerants.....	123
5.4	Designation of Refrigerants.....	124
5.5	Properties of Refrigerants The Properties of Refrigerants may be Grouped into three Categories	128
6.	Application of Refrigeration and Air Conditioning.....	133
	<i>Vinkel Kumar Arora</i>	
6.1	Introduction.....	133
6.2	Domestic Refrigerator	133
6.3	Application of VCRS in Air Conditioners.....	135
6.4	Different Types of Air Conditioner	136
6.5	Application in Cold Chain	138
7.	Internal Combustion Engines	141
	<i>Vinkel Kumar Arora</i>	
7.1	Introduction.....	141
7.2	Classification of I.C. Engines	141

7.3	Terms related to I.C. Engines.....	143
7.4	Constructional details of I.C. Engines	144
7.5	Sequence of Operation	146
7.6	Comparison of Petrol (S.I) and Diesel (C.I) Engines	150
7.7	Valve Timing for Four Stroke Spark-ignition Engines.....	151
7.8	Two stroke engines	152
8.	Air Standard Cycles	157
	<i>Vinkel Kumar Arora</i>	
8.1	Introduction.....	157
8.2	Otto Cycle	158
8.3	Diesel Cycle	161
8.4	Dual Cycle.....	165
9.	Hydraulic Turbines	167
	<i>Vinkel Kumar Arora</i>	
9.1	Introduction.....	167
9.2	Impulse and Reaction Turbines	167
9.3	Difference between Impulse and Reaction Turbines	169
9.4	Classification of Turbines	169
9.5	Pelton Wheel Turbine.....	170
9.6	Francis Turbine	172
9.7	Kaplan Turbines	176
9.8	Difference Between Pelton Francis vs. Kaplan turbines.....	179
9.9	Specific Speed of Turbine.....	179
10.	Hydraulic Pumps.....	181
	<i>Vinkel Kumar Arora</i>	
10.1	Introduction.....	181
10.2	Pump Classification.....	181
10.3	Pump Applications.....	181
10.4	Centrifugal Pumps.....	182
10.5	Turbine Pump.....	184
10.6	Reciprocating Pump.....	184
10.7	Diaphragm Pump	186
10.8	Gear Pump	187
10.9	Screw Pump	189
11.	Simple Lifting Machines.....	191
	<i>Vinkel Kumar Arora</i>	
11.1	Introduction.....	191
11.2	Mechanical Advantage & Efficiency	191
11.3	Laws of Machine	192

11.4	Reversibility of Machine	193
11.5	Condition for Reversibility and Irreversibility of Machine	193
11.6	Simple Wheel & Axle.....	194
11.7	Differential Wheel and Axle	195
11.8	Pulleys.....	196
11.9	Worm and Worm Wheel.....	197
11.10	Single Purchase Crab Winch.....	198
11.11	Double Purchase Crab Winch.....	199
11.12	Simple Screw Jack	199
11.13	Compound Screw Jack.....	200
12.	Power Transmission Methods and Devices.....	201
	<i>Vinkel Kumar Arora</i>	
12.1	Introduction.....	201
12.2	Belt Drive	201
12.3	Tension ratio in Flat belt Drive	205
12.4	Tension Ratio of V- Belt Drive	206
12.5	Power transmitted in a Belt Drive	208
12.6	Centrifugal Tension in the Belt.....	209
12.7	Initial tension in the Belt (To).....	210
12.8	Condition for Maximum Power Transmitted by the Belt Drive	211
12.9	Types of Pulleys	212
12.10	Advantages and Disadvantages of Belt Drives.....	213
12.11	Rope Drive	213
12.12	Chain Drive.....	214
12.13	Gears Drive.....	217
12.14	Velocity ration in Gear Drives.....	222
12.15	Gear Trains: A Gear Train is a Combination of Gears used to Transmit Motion from one Shaft to Other Shaft. They are Classified as Follows	223
13.	Stress and Strains.....	229
	<i>Krishan Kumar Verma</i>	
13.1	Introduction.....	229
13.2	Load classification-on Direction of Application	229
13.3	Concept and Types of Stress and Strains.....	230
13.4	Poisson's Ratio, μ	234
13.5	Stresses and Strains in Simple and Compound Bars Under Axial Loading.....	234
13.6	Strain in Varying Cross- Section Rod	235
13.7	Stresses and Strains in Composite Bar	236
13.8	Stresses and Strains in Compound Bar	236
13.9	Hook's Law	237
13.10	Stress and Strain Diagrams	238

13.11	Stress-Strain Plot for Brittle Material.....	239
13.12	Elastic Constants and their Relationships	239
14.	Thermal Stress & Strains	243
	<i>Lalit Batra</i>	
14.1	Stresses Due to Change in Temperature- Thermal Stresses (σ_p) and Strain (ϵ)	243
14.2	Stresses and Strain when Support Yield.....	244
14.3	Thermal Stresses and Strain in Compound Bar of Different Material	247
15.	Shear Force and Bending Moment	251
	<i>Lalit Batra</i>	
15.1	Shear Force (S.F) & Bending Moment (B.M)	251
15.2	Beam	251
15.3	Different Supports and Their Reactions.....	253
15.4	Shear Force (S.F) and Its Sign Convention.....	254
15.5	Bending Moment (B.M) its sign convention	254
15.6	Shear Force Diagram (S.F.D) & Bending Moment Diagram (B.M.D).....	255
15.7	Some Important Conclusions from S.F.D and B.M.D.....	272
16.	Principle Stress and Principle Planes	275
	<i>Lalit Batra</i>	
16.1	Stresses on Inclined Plane Under Uniaxial Loading.....	275
16.2	Mohr's Circle	277
16.3	Stresses on Inclined Plane under Biaxial Stresses	277
16.4	Mohr's Circle	280
16.5	Stresses on Inclined Plane under Biaxial Stress Combined with Shear Stress.....	280
16.6	Mohr's Circle	281
16.7	Principle Stress and Principle Planes	284
17.	Energy and Exergy Analysis of Milk Processing.....	287
	<i>Gurjeet Singh</i>	
17.1	Overview of Milk Processing Industry	287
17.2	Thermodynamic and Thermoeconomic Analysis	289
17.3	Rice Husk Based Steam Generation System	295
17.4	Milk Processing Plants in Consideration	300
17.5	Summary.....	309
	References	313

BASICS OF MECHANICAL ENGINEERING

Basic of Mechanical Engineering is an under graduate level book for all the engineering streams like Electrical Engineering, Civil Engineering, Food Technology, Electronics etc. This book contains 17 chapters all related to concepts of Mechanical Engineering. An attempt is made to present a book which not only covers the aspects of mechanical engineering related to concept but also to its applications. It is also attempted to cover the majority of the subjects related to mechanical engineering i.e. thermal science, power generation, internal combustion engines, hydraulic machinery, refrigeration, refrigerants, simple lifting machines, power transmission method, strength of materials and energy and exergy analysis of the milk processing industry. However, the justice is done with the topic to restrict within the scope of syllabus but additional information and resources are also provided. The concepts of thermodynamics, internal combustion engines, refrigeration, solid mechanics are applicable over large industrial preview, so this book will be helpful for every engineering graduate to quickly grasp the basic mechanical knowledge.

Vinkel Kumar Arora: Assistant Professor, Department of Food Engineering, National Institute of Food Technology Entrepreneurship & Management, Kundli, Sonipat

Gurjeet Singh: Assistant Professor, Punjab Engineering College, Chandigarh

Krishan Verma: Assistant Professor, Department of Mechanical Engineering JCBUST YMCA, Faridabad

Er. Lalit Batra: Assistant Professor, Bharati Vidyapeeth College of Engineering New Delhi



**NIPA GENX ELECTRONIC
RESOURCES & SOLUTIONS P. LTD.**

101,103, Vikas Surya Plaza, CU Block
L.S.C.Market, Pitam Pura, New Delhi-110 034
Ph : +91 11 27341616, 27341717, 27341718
E-mail: newindiapublishingagency@gmail.com
www: www.nipabooks.com

